

CHAPTER ONE

ENVIRONMENT STATISTICS: FRAME WORK AND INDICATORS

1.1 Introduction

The objective of environment statistics is to provide information about the environment, its most important changes over time and across locations, and the main factors that influence them. Ultimately, environment statistics aim at providing high quality statistical information to improve knowledge of the environment, to support evidence-based policy and decision making, and to provide information for the general public, as well as for specific user groups. Environment statistics are multidisciplinary and cross-cutting, involving numerous sources and stakeholders

Environment statistics aggregate, synthesize and structure environmental and other data according to statistical methods, standards and procedures. It is the role of environment statistics to process environmental data into meaningful statistics that describe the state and trends of the environment and the main processes affecting them. Not all environmental data are used in the production of environment statistics. The Framework for the Development of Environment Statistics (FDES) provides a framework that marks out environmental data that fall within its scope and then structures, synthesizes and aggregates them into meaningful statistics.

The scope of environment statistics covers biophysical aspects of the environment and those aspects of the human sub-system that directly influence and interact with the environment. Within this scope, environment statistics describe the state and changes of environmental conditions, the quality and availability of environmental resources, the

impact of human activities and natural events on the environment, the impact of changing environmental conditions, as well as the social actions and economic measures taken by societies to avoid or mitigate these impacts and to restore and maintain the capacity of the environment to provide the services that are essential for life and human wellbeing

Environment statistics support evidence based policy making by enabling the identification of environmental policy issues and the objective quantification of measures and impacts of policy initiatives. They strengthen assessments through quantitative metrics, making analyses more robust through the use of timely and comparable data. The type, the level of thematic, spatial and temporal aggregation and the format of environment statistics depend on the type of the user and the intended purpose of use. The main products of environment statistics are detailed tabulated environment statistics series, environmental accounts and environmental indicators

Main uses and user groups of environment statistics

Different users need environment statistics at different levels of aggregation and depths of information. They may need cross-cutting environment statistics data sets, for instance regarding climate change. In other cases they may only be interested in particular topics and themes pertaining to specific sectoral analysis and policy making. Policy and decision makers, and the general public would tend to use environmental indicators, whereas researchers, analysts, and experts may be more inclined to look at extensive and detailed environment statistics.

Environment statistics serve a variety of users, including but not restricted to:

- i. Policy and decision makers at all levels;
- ii. The general public, including media and civil society;
- iii. Analysts and researchers;
- iv. Academia; and
- v. International agencies

The field of environment statistics has no single, overarching, internationally agreed classification of the environment for statistical purposes. Instead, there are a number of coexisting and emerging classifications and categorizations for specific subject areas in environment statistics. These include standardized statistical classifications as well as less formalized groupings or categories. Some of the classifications and categories that have been used in the environmental field have not been developed specifically for statistical purposes, and therefore have to be linked to statistical classifications

UNSD developed and published in 1984 'A Framework for the Development of Environment Statistics (FDES).' The FDES sets out the scope of environment statistics by relating the components of the environment to information categories that are based on the recognition that environmental problems are the result of human activities and natural events reflecting a sequence of action, impact, and reaction. Relevant information, therefore, refers to social and economic activities and natural events, their effects on the environment, and the responses to these effects by the society. The contents of the FDES are "statistical topics"; they are those aspects of environmental concerns that can be subjected to statistical description and analysis. It is a flexible framework that is used for developing and organizing

environmental and related socio-economic information.

The scope of environment statistics include the media of the natural environment (air, water, land/soil), the biota found within these media, and human settlements. Within the broad range of subject areas, environment statistics describe the quality and availability of natural resources, human activities and natural events that affect the environment, the impacts of these activities and events, and social responses to these impacts.

1.2 Development versus Environment Degradation

Developmental activities are measured in terms of national products, which in turn are defined as production of goods and services during accounting period. However, certain environmental functions, which are crucial for economic performance and generation of human welfare such as provision of natural resources to production and consumption activities, waste absorption by environmental media and environmental services of life support and other human amenities, are taken into account only partly in conventional accounts. The scarcities of natural resources now threaten the sustained productivity of the economy and economic production and consumption activities. These activities impair environmental quality by over loading natural sinks with wastes and pollutants. The environmental consequence of development tends to offset many benefits that may be accruing to individuals and societies on account of rising incomes. There are direct costs on the health of individuals, their longevity and on quality of life on account of deterioration in environmental quality to mention a few. More importantly, the environmental damage can also undermine future attainments and productivity, if the factors of production are

adversely affected. Therefore, the private and social costs of the use of the natural resources and the degradation of the environment may be taken into account for the *sustainable development* in the conventional accounts.

1.3 Environmental Indicators

List of environmental and related socio-economic indicators

The United Nations Statistical Division (UNSD) developed a list of environmental indicators in collaboration with the Inter-governmental Working Group on the

Advancement of Environment Statistics. The fourth meeting of the Working Group (Stockholm, 6 - 10 February 1995) agreed on the List of environmental and related socioeconomic indicators given below. The Statistical Commission, at its twenty-eighth session (New York, 27 February - 3 March 1995), approved this list for international compilation by UNSD. The indicators that are bolded in the list were intended for short-term compilation directly from national statistical services or from other international organizations or specialized agencies.

Agenda Issues (clusters)	A. Socioeconomic activities, events	B. Impacts and effects	C. Responses to impacts	D. Inventories, stocks, background conditions
ECONOMIC ISSUES	Real GDP per capita growth rate Production and consumption patterns Investment share in GDP	EDP/EVA per capita Capital accumulation (environmentally adjusted)	Environmental protection expenditure as % of GDP Environmental taxes and subsidies as % of government revenue	Produced capital stock
SOCIAL/ DEMOGRAPHIC ISSUES	Population growth rate Population density Urban/rural migration rate Calorie supply per capita	% of urban population exposed to concentrations of SO ₂ , particulates, ozone, CO and Pb Infant mortality rate Incidence of environmentally related diseases		Population living in absolute poverty Adult literacy rate Combined primary and secondary school enrollment ratio Life expectancy at birth Females per 100 males in

				secondary school
AIR/CLIMATE	<p>Emissions of CO₂, SO₂ and NO_x</p> <p>Consumption of ozone depleting substances</p>	<p>Ambient concentrations of CO, SO₂, NO_x, O₃ and TSP in urban areas</p> <p>Air quality index</p>	<p>Expenditure on air pollution abatement</p> <p>Reduction in consumption of substances and emissions</p>	Weather and climate conditions
LAND/SOIL	<p>Land change use</p> <p>Livestock per km² of arid and semi-arid lands</p> <p>Use of fertilizers</p> <p>Use of agricultural pesticides</p>	<p>Area affected by soil erosion</p> <p>Land affected by desertification</p> <p>Area affected by salinization and water logging</p>	Protected area as % of total land area	Arable land per capita
WATER Fresh water resources	<p>Industrial, agricultural and municipal discharges directly into freshwater bodies</p> <p>Annual withdrawals of ground and surface water</p> <p>Domestic consumption of water per capita</p> <p>Industrial, agricultural water use per GDP</p>	<p>Concentration of lead, cadmium, mercury and pesticides in fresh water bodies</p> <p>Concentration of fecal coliform in fresh water bodies</p> <p>Acidification of fresh water bodies</p> <p>BOD and COD in fresh water bodies</p> <p>Water quality index by fresh water bodies</p>	<p>Waste water treatment, total and by type of treatment (% of population served)</p> <p>Access to safe drinking water (% of population served)</p>	Groundwater reserves
Marine water resources	<p>Industrial, agricultural and municipal discharges directly into marine water bodies</p>	<p>Deviation in stock from maximum sustainable yield</p>		

	Discharges of oil into coastal waters	of marine species Loading of N and P in coastal waters		
OTHER NATURAL RESOURCES				
Biological resources	Annual roundwood production	Deforestation rate	Reforestation rate	Forest inventory
	Fuelwood consumption per capita	Threatened, extinct species	Protected forest area as % of total land area	Ecosystems inventory Fauna and flora inventory Fish stocks
Mineral (incl. energy) resources	Catches of marine species	Depletion of mineral resources (% of proven reserves)		Proven mineral reserves
	Annual energy consumption per capita	Lifetime of proven reserves		Proven energy reserves
	Extraction of other mineral resources			
WASTE	Municipal waste disposal	Area of land contaminated by toxic waste	Expenditure on waste collection and treatment	
	Generation of hazardous waste		Waste recycling	
	Imports and exports of hazardous wastes			
HUMAN SETTLEMENTS	Rate of growth of urban population	Area and population in marginal settlements	Expenditure on low-cost housing	Stock of shelter and infrastructure
	% of population in urban areas	Shelter index		
	Motor vehicles in use per 1000 habitants	% of population with sanitary services		

NATURAL DISASTERS	Frequency of natural disasters	Cost and number of injuries and fatalities related to natural disasters	Expenditure on disaster prevention and mitigation	Human settlements vulnerable to natural disasters
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TABLE 1.3.2: SOME IMPACTS OF DEVELOPMENT ACTIVITIES ON ENVIRONMENT

Development Activities	Major Impacts on Environment
Forest clearing and land resettlements	Extinction of rare species of flora and fauna, creation of condition for mosquito breeding leading to infectious diseases such as malaria, dengue etc.
Shifting cultivation in upland agriculture	Soil erosion in upland areas, soil fertility declines due to shorter cultivation cycle, which is practiced due to population pressure, flooding of low land areas. The problems could be resolved by terraced cultivation.
Agro industries	Air pollution due to burning of bagasse as fuel in sugar mills, large amount of highly polluting organic wastes, surface water pollution .
Introduction of new varieties of cereals	Reduction of genetic diversity of traditional monoculture resulting in instability, danger of multiplication of local strains of fungus, bacteria or virus on new variety
Use of pesticides	Organism develops resistance and new control methods are needed (e.g. in malaria, widespread use of dieldrin as a prophylactic agent against pests of oil palms made the problem worse), creation of complex and widespread environment problems. The pesticides used in agriculture sometimes go into food chain or in water bodies which may result in harmful health hazards.
Timber extraction	Degrades land, destroys surface soil, reduces production potential of future forests.
Urbanisation and industrialization	Concentration of population in urban centers make huge demands on production in rural areas and put pressures on land, air and water pollution.
Water resource projects, e.g. Dam, extensive irrigation	Human settlement & resettlement, spread of waterborne diseases, reduction of fisheries, siltation, physical changes e.g. temperature, humidity.

1.4 Emissions, Discharges and their Sources

1.4.1. The environmental stress caused by developmental activities emanating

from emissions and discharges of various substances into air, water and soil. These emissions and discharges have not only local effects but regional and global effects too.

TABLE 1.4.1: LOCAL, REGIONAL AND GLOBAL EFFECTS OF POLLUTION

Local effects	Regional	Over Marine Water and Continents	Global
Heavy metals in air, soil, water and plants, e.g. From industrial emissions and Discharges Noise, Smell, Air pollution.	Eutrophication, Contaminants in the soil & water, Landscape changes due to mining or agriculture.	Eutrophication, Acidification, Environment Contamination due to Radioactivity	Changes the climate due to ozone depletion and the greenhouse effect.

1.4.2 Acidifying emissions

Sulphur dioxide and nitrogen oxides emitted into the air are converted into acids. At their deposition, they have an acidifying effect on soil and water. The emission of ammonia also contributes to the acidification. Main sources of emission of sulphur dioxide in the air are due to burning of Sulphur containing fuel like coal mine, power plants, oil by vehicles, and also due to refining of oils in refineries.

1.4.3 Emissions of volatile organic substances

Volatile organic substances may also effect health. Many of such substances are carcinogenic. In combination with nitrogen oxides and in sunlight, some of them might form ozone and other photochemical oxidants. These are harmful to plants.

1.4.4 Gases affecting the climate

The greenhouse gases (carbon dioxide, methane etc.) prevent some of the heat radiation from the earth into space. The concentration of green house gases is responsible for raising the temperature of the earth in a long term. Eighty percent of the effect of the greenhouse gases is caused by carbon dioxide itself.

1.4.5 Eutrophicating discharges into water

Nutrients, mainly nitrogen and phosphorus, contribute to the eutrophication of lakes, rivers and marine waters. Approximately, half of the nitrogen discharges are estimated to originate from agricultural land. A considerable proportion of the phosphorous discharge derives from waste water not passing through sewage treatment plants. In addition to discharges from human activities, there is a natural leaching from various types of soil. The quantities are estimated to be of about the same magnitude as those originating from human activities.

1.4.6 Emissions of heavy metals

Discharges and emissions of heavy metals are difficult to estimate. A large proportion of emissions/discharges of heavy metals into air originates from the iron and steel industry. Vehicular traffic is the main source of lead emissions. Mines and mining wastes account for the major part of the discharges of heavy metals into water. Besides, Cadmium depositions originate from commercial fertilizers containing phosphorus.

TABLE 1.4.2: SOME MAJOR POLLUTANTS AND THEIR SOURCES

Pollutant	Source
Carbon monoxide	Incomplete fuel combustion (e.g. two/four stroke engines)
Sulphur dioxide	Burning of sulphur containing fuel like coal in Power Plants and emission by vehicles
Suspended particulate matter	Smoke from domestic, industrial and vehicular sources.
Oxides of nitrogen	Fuel combustion of motor vehicles, emission from power stations and industrial furnaces
Volatile hydrocarbons	Partial combustion of carbonaceous fuels (two stroke engines, industrial processes, disposal of solid wastes).
Oxidants and ozone	Emissions from motor vehicles, photochemical reactions of nitrogen oxides and reactive hydrocarbons
Lead	Emissions from motor vehicles

TABLE 1.4.3: POLLUTANTS AND THEIR RELATED HEALTH HAZARDS

Pollutants	Health Effects
Carbon Monoxide (from gasoline cars, 2-wheelers, 3-wheelers)	Fatal in case of large dose: aggravates heart disorders; effects central nervous system; impairs oxygen carrying capacity of blood
Nitrogen Oxides (NO _x) (from diesel vehicles)	Irritation of respiratory tract
Ozone	Eye, nose and throat irritation; risk asthmatics, children and those involved in heavy exercise
Lead (from petrol vehicles)	Extremely toxic: effects nervous system and blood; can impair mental development of children, causes hypertension
Hydrocarbons (mainly from 2-wheelers and 3-wheelers)	Drowsiness, eye irritation, coughing
Benzene	Carcinogenic
Aldehydes	Irritation of eyes, nose and throat, sneezing, coughing, nausea, breathing difficulties; carcinogenic in animals
Polycyclic Aromatic Hydrocarbons PAH (from diesel vehicles)	Carcinogenic

1.4.7 Health Aspects of Water Quality

Water borne diseases are single most important factor responsible for nearly 80% of human mortality in India. Children are

worst affected, especially in rural areas and urban slums. Typical water born diseases and their causative factors are summarised in the Table 1.4.4.

Table 1.4.4: Water born disease and their causative factors

Name of the Disease	Causative Organism
1. Water-borne diseases Bacterial <ul style="list-style-type: none"> ➤ Typhoid ➤ Gastroenteritis ➤ Paratyphoid ➤ Cholera ➤ Bacterial dysentery 	Salmonella typhi Vibrio cholerae Shmndllaparayphi Enterotoxigenic Escherichia coli Variety of Escherichia coli
Viral <ul style="list-style-type: none"> ➤ Infectious hepatitis ➤ Poliomyelitis ➤ Diarrhea Diseases ➤ Other symptoms of enteric diseases 	Hepatitis-A-virus Polio-virus Rota-virus, Norwalk agent, Other virus Echono-virus, Coxsackie-virus
Protozoan Amoebic dysentery	Entamoebahystolitica
2. Water-washed diseases <ul style="list-style-type: none"> ➤ Scabies ➤ Trachoma ➤ Bacillary dysentery 	Various skin fungus species Trachoma infecting eyes E. coli
3. Water-based diseases <ul style="list-style-type: none"> ➤ Schistosomiasis ➤ Guinea worm 	Schistosoma sp. Guinea worm
4. Infecton through water related insect vectors <ul style="list-style-type: none"> ➤ Sleeping sickness ➤ Malaria 	Trapanosoma through tsetse fly Plasmodium through Anaphelis
5. Infection primarily due to defective sanitation <ul style="list-style-type: none"> ➤ Hookworm 	Hook worm, Ascaris

Revision of FDES

The Framework for the Development of Environment Statistics (FDES) was first published in 1984 by the United Nations Statistics Division (UNSD). The 1984 FDES and subsequent publications have been a useful framework for guiding countries in the development

their environment statistics programmes. During the time since its publication there have been a number of scientific, political, technological, statistical and experience-based developments which suggested that the FDES was ready for revision.

As a consequence, the United Nations Statistical Commission, at its 41st session (23-26 February 2010), endorsed a work programme and the establishment of an Expert Group for the revision of the FDES. The members of the Expert Group represented producers and users of environment statistics of countries from all regions and at different stages of development, as well as international organizations, specialized agencies and non-governmental organizations. ADG (SSD) was a member of the Expert Group.

The revision process

The revision was based on an agreed set of criteria and has been supported by extensive international expert consultation. The 1984 FDES was used as the starting point. It was revised taking into account the lessons learned during its application in different countries as well as improved scientific knowledge about the environment and new requirements created by emerging environmental concerns and policy issues including major multilateral environmental agreements (MEAs). The revision has also taken into account the increasing prominence of environmental sustainability and sustainable development issues and concepts. Existing environment statistics and indicator frameworks were analyzed, including major developments in the field of environmental-economic accounting and selected thematic developments pertinent to environment statistics.

The revision was undertaken as part of UNSD's work programme on environment statistics, supported by the Expert Group on the Revision of the FDES. The drafts were reviewed in four face-to-face meetings of the Expert

Group and in several rounds of electronic discussion. The Core Set of Environment Statistics was tested by 25 countries and two organizations. The final draft of the FDES was subjected to a Global Consultation, yielding feedback from 71 countries, areas and organizations and the FDES 2013 is the result of this wide consultation process. UN Statistical Commission at its 44th Session held in 2013 endorsed the revised framework as the framework for strengthening environment statistics programmes in countries and recognized it as a useful tool in the context of sustainable Development Goals and Post 2015 Development Agenda.

The revised FDES 2013 is a multipurpose conceptual and statistical framework that is comprehensive and integrative in nature. It provides an organizing structure to guide the collection and compilation of environment statistics and to synthesize data from various subject areas and sources. It is broad and holistic in nature, covering the issues and aspects of the environment that are relevant for analysis, policy and decision making. The FDES is structured in a way that allows links to economic and social domains. It seeks to be compatible with other frameworks and systems, both statistical and analytical, such as for instance the System of Environmental-Economic Accounting (SEEA), the Driving force – Pressure – State – Impact – Response (DPSIR) framework, and the Millennium Development Goals (MDGs) indicator framework. As such, the FDES facilitates data integration within environment statistics and with economic and social statistics.

The FDES 2013 sets out a comprehensive (though not exhaustive)

list of statistics (the Basic Set of Environment Statistics) that can be used to measure the statistical topics relating to environment. The Basic Set is organized in three tiers, based on the level of relevance, availability of data and methodological development of the statistics.

Within this scope, a Core Set of Environment Statistics has been identified as Tier 1. The objective of the Core Set is to serve as an agreed, limited set of environment statistics that are of high priority and relevance to most countries. Harmonized international definitions, classifications and data collection methods for these statistics will be provided in subsequent methodological handbooks to facilitate their production in an internationally comparable manner.

The FDES 2013 is relevant to, and recommended for use by, countries at any stage of development. However, it is particularly useful to guide the formulation of environment statistics programmes in countries at early stages in the development of environment statistics by: (i) identifying the scope and constituent components, sub-components and statistical topics relevant for them; (ii) contributing to the assessment of data requirements, sources, availability and gaps; (iii) guiding the development of multipurpose data collection processes and databases; and (iv) assisting in the co-ordination and organization of environment statistics, given the inter-institutional nature of the domain.

The FDES organizes environment statistics into a structure consisting of components,

subcomponents, statistical topics, and individual statistics using a multi-level approach. The first level of the structure consists of six fundamental components that follow the FDES conceptual framework.

The first component brings together statistics related to the conditions and quality of the environment and their change. The second component groups together statistics related to availability and use of environmental resources (ecosystem provisioning services, land and subsoil resources). The third component includes statistics related to the use of regulating services of the environment for the discharge of residuals from production and consumption processes. Statistics related to extreme events and disasters (both natural and technological) and their impacts are covered by the fourth component. The fifth component brings together statistics related to environmental conditions and impacts within human settlements. The sixth component groups statistics relevant to societal responses and economic measures aimed at protecting the environment and managing environmental resources.

Environmental conditions and quality (Component 1) are at the centre of the FDES. The other five components have been set up based on their relationship with the central Component 1. As presented in chart 1 below, all six components are intrinsically related with each other.

Chart1: Component of FDES 2013

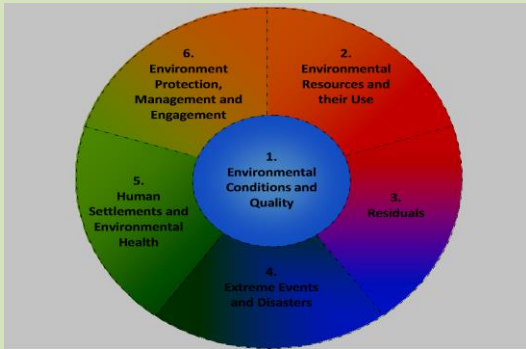


Chart 1 shows the six components of the FDES. The dotted lines separating the components are an indication of the continuous interactions among them. These interactions are between and among all the components of the FDES. It should be noted that a two dimensional diagram can only provide a limited visualisation of the complex and interrelated nature of the relationships between humans and the environment.

The revised FDES uses a multi-level approach. The first level of the structure defines the six fundamental components. Each individual component is further broken down into its respective sub-components (second level) and statistical topics (third level). Each level uses numbering conventions. The final level contains the actual individual environment statistics.

The components, sub-components, statistical topics and individual statistics of the FDES define the scope and boundaries of environment statistics. They provide an organizing structure for synthesizing and presenting the information in a comprehensive, consistent and coherent manner.

Table 1: Components and Sub-components of the FDES

Component 1: Environmental Conditions and Quality	Sub-component 1.1: Physical Conditions Sub-component 1.2: Land Cover, Ecosystems and Biodiversity Sub-component 1.3: Environmental Quality
Component 2: Environmental Resources and their Use	Sub-component 2.1: Non-energy Mineral Resources Sub-component 2.2: Energy Resources Sub-component 2.3: Land Sub-component 2.4: Soil Resources Sub-component 2.5: Biological Resources Sub-component 2.6: Water Resources
Component 3: Residuals	Sub-component 3.1: Emissions to Air Sub-component 3.2: Generation and Management of Wastewater Sub-component 3.3: Generation and Management of Waste
Component 4: Extreme Events and Disasters	Sub-component 4.1: Natural Extreme Events and Disasters Sub-component 4.2: Technological Disasters
Component 5: Human Settlements and Environmental Health	Sub-component 5.1: Human Settlements Sub-component 5.2: Environmental Health
Component 6:	Sub-component 6.1:

Environment Protection, Management and Engagement	Environment Protection and Resource Management Expenditure Sub-component 6.2: Environmental Governance and Regulation Sub-component 6.3: Extreme Event Preparedness and Disaster Management Sub-component 6.4: Environmental Information and Awareness
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consultation during August-October 2012. The draft revised frame work was also discussed in a national workshop organised at Hyderabad in September 2012. United Nation Statistical Commission (UNSC) in its 44th Session recognized that revised FDES 2013 is a useful tool in the context of sustainable Development Goals and Post 2015 Development Agenda. The final version of revised FDES will be published by UNSD in 2014. The Compendium of Environment Statistics will be revised in consistent with the revised UN frame work.

India also participated in the Pilot of the Revised FDES 2013 and Global

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